

WHAT WE CLAIM ARE:

1. A method of manufacturing a semiconductor device, comprising the steps of:

(a) forming a pattern on a surface of a semiconductor substrate,  
said pattern including a first silicon nitride film and having a window used for

5 forming an isolation trench;

(b) etching said semiconductor substrate by using said pattern as a  
mask, to form the isolation trench;

(c) depositing a second silicon nitride film covering an inner surface  
of said isolation trench;

10 (d) forming a first silicon oxide film covering said second silicon  
nitride film and burying said isolation trench;

(f) etching said first silicon oxide film to remove said first silicon  
oxide film in an upper region of said isolation trench;

(g) etching and removing exposed part of said second silicon nitride  
15 film;

(h) forming a second silicon oxide film burying said isolation trench;

(i) chemical-mechanical-polishing said second silicon oxide film by  
using said first silicon nitride film as a stopper; and

(j) etching and removing said first silicon nitride film exposed.

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2. The method of manufacturing a semiconductor device according to claim 1,  
further comprising the step of:

(e) before said step (f), chemical-mechanical-polishing said first  
silicon oxide film on said second silicon nitride film to form a flat surface.

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3. The method of manufacturing a semiconductor device according to claim 1, wherein said step (f) is performed by dilute hydrofluoric acid or chemical dry etching using gas which contains CF.
- 5 4. The method of manufacturing a semiconductor device according to claim 1, wherein step (g) is performed by using hot phosphoric acid.
5. The method of manufacturing a semiconductor device according to claim 1, wherein said step (g) removes said second silicon nitride film to a depth of 80 to  
10 150 nm from the surface of said semiconductor substrate.
6. The method of manufacturing a semiconductor device according to claim 1, wherein a thickness of said second silicon nitride film is 20 to 40 nm.
- 15 7. The method of manufacturing a semiconductor device according to claim 1, further comprising the step of:  
(k) after said step (d), annealing said first silicon oxide film to make densities of said first silicon oxide film uniform.
- 20 8. The method of manufacturing a semiconductor device according to claim 1, further comprising a step of:  
(k) after said step (h), annealing said second silicon oxide film to make said second silicon oxide film dense.
- 25 9. The method of manufacturing a semiconductor device according to claim 1,

wherein said step (g) etches the exposed part of said second silicon nitride film and further over-etches to retract a side wall of said first silicon nitride film on an active region and to lower an upper surface of said silicon nitride film.

5 10. The method of manufacturing a semiconductor device according to claim 8, wherein a retracted amount of said side wall is 6 nm to 12 nm.

11. The method of manufacturing a semiconductor device according to claim 1, wherein said step (a) stacks a cover layer, having different etching characteristics  
10 from those of silicon nitride, on said first silicon nitride film, and said step (g) etches said exposed second silicon nitride film and further over-etches to retract a side wall of said first silicon nitride film on an active region, while not lowering an upper surface of said silicon nitride film.

15 12. The method of manufacturing a semiconductor device according to claim 11, wherein said cover layer is a silicon oxide film.

13. The method of manufacturing a semiconductor device according to claim 1, wherein said step (h) leaves said first silicon oxide film in a lower region of said  
20 isolation trench and forms a second silicon oxide film on said first silicon oxide film.

14. The method of manufacturing a semiconductor device according to claim 1, further comprising a step of:

25 (l) after said step (g) and before said step (h), removing said first

silicon oxide film left in a lower region of said isolation trench,

wherein said step (h) forms said second silicon oxide film in such a manner that a void is formed in a region surrounded by said second silicon nitride film.

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15. A semiconductor device comprising:

a semiconductor substrate;

an isolation trench formed under a surface of said semiconductor substrate;

10 a liner of a silicon nitride film covering a lower inner surface of said isolation trench retracted below the surface of said semiconductor substrate;

a first silicon oxide film formed in a region surrounded by said liner of the silicon nitride film and burying a lower region of said isolation trench;

a second silicon oxide film formed on said first silicon oxide film and  
15 burying an upper region of said isolation trench; and  
active regions defined by said isolation trench.

16. The semiconductor device according to claim 15, wherein said liner of the silicon nitride film is retracted below the surface of said semiconductor substrate  
20 by 80 nm to 150 nm.

17. The semiconductor device according to claim 15, wherein said liner of the silicon nitride film has a thickness of 20 nm to 40 nm.

25 18. The semiconductor device according to claim 15, wherein said second

silicon oxide film covers a corner of said active region.

19. The semiconductor device according to claim 15, wherein a width of said isolation trench is 100 nm or narrower.

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20. A semiconductor device comprising:

a semiconductor substrate;

an isolation trench formed under a surface of said semiconductor substrate;

10 a liner of a silicon nitride film covering a lower inner surface of said isolation trench retracted below the surface of said semiconductor substrate;

a silicon oxide film burying said isolation trench and having a void in a region surrounded by said liner of the silicon nitride film; and

active regions defined by said isolation trench.

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21. The semiconductor device according to claim 20, wherein said liner of the silicon nitride film is retracted below the surface of said semiconductor substrate by 80 nm to 150 nm.

20 22. The semiconductor device according to claim 20, wherein said liner of the silicon nitride film have a thickness of 20 nm to 40 nm.

23. The semiconductor device according to claim 20, wherein said silicon oxide film covers a corner of said active region.

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24. The semiconductor device according to claim 20, wherein a width of said isolation trench is 100 nm or narrower.